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The effect of fermentation time on the product quality of purple sweet potato (*Ipomea batatas*) probiotic ice cream with starter culture of *Lactobacillus plantarum* B1765

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Abstract

This research aims to determine the effect of fermentation time of purple sweet potato probiotic ice cream (*Ipomea batatas*) with a starter culture of *Lactobacillus plantarum* B1765 on microbiological quality (total lactic acid bacteria/LAB), chemical qualities (pH and total titrated acid/TTA), and organoleptic qualities (color, flavor, taste, and texture). The research method used an experimental method with a complete random design (CRD) with variations of fermentation time 0, 6, 18, and 24 hours. The total LAB was enumerated by the method of Total Plate Count (TPC), the pH value was determined using a pH meter, TTA was calculated using the acid-base titration, and hedonic test for organoleptic qualities with 30 panelists. The results showed that fermentation time affects the total LAB, pH value, TTA, flavor, taste, and texture, but do not affect the color. The total LAB increased by 2 log cycle from 7.16 x 10^7 CFU/mL up to 1.82 x 10^9 CFU/mL. The pH value decreased from 5.65 to 3.54. Then, the TTA value increased from 0,89% to 2,01%. The average value of panelist's level preference on color, flavor, taste, and texture was 3.37; 2.99; 3.1; 3.33, respectively, which showed a tendency to like. The best treatment was purple sweet potato probiotic ice cream with a fermentation time of 18 hours. Total LAB and TTA were fulfilled the Indonesian National Standard (INS) for dairy based probiotic products, so this product could be developed as probiotics agent.

Keywords: Probiotic Ice Cream; *L. plantarum* B1765; Purple Sweet Potato (*Ipomea Batatas*): Product Quality

1. Introduction

Non-communicable diseases (NCD) or degenerative diseases dominate the mortality rate in Indonesia (1). The main cause of degenerative diseases is an unhealthy lifestyle, one of which is the low public awareness of food consumption. Poor diet is proven to cause various degenerative diseases, such as cancer, diabetes mellitus, cataracts, coronary heart disease, and so on. One alternative to prevent degenerative diseases is consuming functional foods. Functional food is the food that is naturally and has also undergone a process, has one or more compounds that have certain physiological functions for health (2). The use of probiotics can be applied as the functional foods for some generations. Probiotics have many beneficial influences, such as anti-microbial activity to protect colonization infection of the gastrointestinal tract from pathogenic microorganisms, immune system stimulating effect, centralize toxins entering the body, protect the urogenital system, and can help to protect cardiovascular diseases triggered by hypertension (such as heart attacks and stroke), changes in nervous system function (such as huntington's disease, alzheimer's, drug abuse, learning and memory disorders, anxiety and depression), diabetes, cancer, and asthma (3).

Purple sweet potato is one of the probiotic agents. Purple sweet potatoes contain carbohydrates that can be utilized by probiotic bacteria to produce organic acids. Based on the U.S Department of Agriculture, the carbohydrate content found in sweet potatoes is 20.12 grams in 100 grams of raw sweet potatoes. In addition, it also contains 1.57 grams of protein in 100 grams of raw sweet potatoes (4).

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Most commonly microorganisms used as probiotics are the genus of *Lactobacillus* and *Bifidobacterium* that classified as lactic acid bacteria (LAB) (3). *Lactobacillus plantarum* B1765 is an isolate from the bekasam of milkfish (*Chanos chanos)* (5). *L. plantarum* B1765 has amylolytic properties that can convert starch into glucose (6). *L. plantarum* B1765 is also able to show characteristics as a probiotic, it is resistant to gastrointestinal pH of pH 1-8, resistant to bile salts in the range of 0.1-1% with a percentage of survival above 90%, resistant to the antibiotic of amoxicillin clavunate at concentrations above 50 ppm and shows antagonistic properties in pathogens of *Staphylococcus aureus* and *Escherichia coli* (7).

Based on the description above, the combination of purple sweet potato extract and probiotics of *L. plantarum* B1765 is expected to be a new innovation in processing of purple sweet potato into probiotic ice cream. The aim of this research was to evaluate the effect of the variation of fermentation time to the microbiology, chemical, and organoleptic qualities of product.

2. Material and methods

2.1. Equipment and Materials

The equipment used in this research were analytical balance (*Denver Instrument*), refrigerator (*Aqua*), autoclave (*Hirayama HVE-50*), glassware (*Pyrex*), micropipette (*D-LAB*), blue tip (*Eppendorf*), magnetic stirrer (*D-LAB*), centrifuge tube (*GP*), centrifuge (*Eppendorf 5810*), incubator (*Memmert*), pH meter (*Eutech*), laminar air flow (*Thermo Fisher Scientific 1300 Series* A2), vortex mixer (*LAB-NET*), blender (*Philips*), mixer (*Philips*), electric stove (*Maspion*), knife, cutting board, 400 mesh filter cloth, plastic wrap, spiritus burner, stopwatch, ice cream cup, food container, stative and clamps.

The materials used in this research included: purple sweet potatoes (*Ipomea batatas var. Ayamurasaki*), full cream UHT milk (*Ultra Milk*), skim milk (*Petit Eric*), whipped cream (*Haan*), egg yolk powder, CMC (*Kopoe-kopoe*), sucrose (*Gulaku*), MRS Broth (*Merck*), *L. plantarum* B1765, NaCl (*PUDAK Scientific*), jelly powder white plain *(satellite)*, $CaCO_3$ (*PUDAK Scientific*), NaOH (*Merck*), indicators phenolphthalein *(Merck),* and aquademineral.

2.2. Procedures and Analysis Methods

2.2.1. Preparation of Starter Culture of L. plantarum B1765

The starter culture was made with as much as 1000 µL isolates *L. plantarum* B1765 inoculated into 9 mL MRS broth and incubated at 37°C for 24 hours. Then, the grown culture was separated by centrifugation at 3500 rpm for 5 minutes, the supernatant was removed by decantation, the pellets were washed with 0.85% NaCl sterile solution, and centrifugation was carried out again at the same speed and time to separate MRS broth. Pellets were suspended in 10 mL of 0.85% NaCl sterile solution and then vortex for further use as a starter culture in the manufacture of purple sweet potato probiotic ice cream.

2.2.2. Producing Purple Sweet Potato Extract

Purple sweet potato *var. Ayamurasaki* was obtained from Lawang Traditional Market (Malang, Indonesia). Washing purple sweet potatoes, peeling, cutting into small pieces, then, blanching using hot water vapor for 15 minutes, then weighing and adding water in a ratio of (1:2). After that, these mixtures were blended for 5 minutes, filtered using a filter cloth to separate the sediment and those filtrates. The filtrate was taken for the further use.

2.2.3. Producing Purple Sweet Potato Probiotic Ice Cream

UHT milk full cream mixed with purple sweet potato filtrate 50% (v/v), then added skim milk 5% (b/v), sucrose 20% (b/v), CMC 0.2% (b/v), egg yolk powder 0.1% (b/v), and whipped cream 5% (b/v), all the ingredients were mixed to become dough. Next, the finished dough was pasteurized at a temperature of 80±2°C for 10 minutes and cooled to a temperature of 40-45°C. Then, homogenized using a mixer at speed 2 for 10 minutes. Next, inoculated starter of *L. plantarum* B1765 as much as 4% aseptically then incubated at a temperature of 37°C for 0 hours, 6 hours, 18 hours, and 24 hours. After being fermented, continued to aging process at a temperature of 4°C for 20 hours. Then, the foaming process conventionally (without ice cream maker*)* through putting ice cream in the freezer for 5 hours, then removed from the freezer and shaken. Next, stored again into the freezer. The shaking and freezing process were repeated in three times. The next step of hardening ice cream by stored in freezer (< -10°C) for 24 hours.

2.3. Microbiology quality (Total LAB)

Total LAB was measured using Total Plate Count (TPC) method. 1 mL of the sample was inserted into a centrifuge tube containing 9 mL of 0.85% NaCl solution, then continued a dilution series of 10^{-1} up to 10^{-9}. Each dilution series was taken in the amount of 1 mL and put in a petri dish. Then, the petri dish was poured into media of jelly MRS (MRS broth + 1.5% plain white jelly, 1% $CaCO_3$) sterile and moved in a circle for equally microbial cells. Waiting the media until solidified and then incubated at a temperature of 37°C for 48 hours with upside-down petri dish. The growth of colonies could be identified through the existence of a clear circumference zone and the total yield of bacteria stated in units of colony forming unit/mL (CFU/mL) by calculation using the following formula:

$$\text{Total LAB} = \text{total colony x} \frac{1}{\text{dilution factor (DF)}}$$

2.3.1. Chemical qualities (pH and TTA)

The pH value was measured using a pre-calibrated pH meter. The electrodes were rinsed with aquadest and dried, then dipped in a sample. the pH meter was just put until showed a stable number.

Total titrated acid was stated as the percentage of lactic acid in the sample measured using acid-base titration method. Ice cream sample as much as 2.5 mL diluted in a flask measuring 250 mL, then pipetted as much as 20 ml and put in the flask erlenmeyer, then added indicator of phenolphthalein as much 2-3 drops and titrated with NaOH 0.1 N. Titration was stopped when there has been a permanent pink discoloration. The total titrated acid was calculated by the following formula:

$$\%\text{TTA} = \frac{\text{V NaOH x N NaOH x DF x MW}}{\text{W (g) x 1000}} \text{ x } 100\%$$

V = Volume
DF = Dilution factor
N = Normality
MW = Molecular weight of lactic acid
W = Sample weight

2.3.2. Organoleptic Quality Testing

Organoleptic quality testing was done by scoring method or hedonic test to 30 untrained panelists using questionnaire sheet instruments. Panelists were asked to express their opinion regarding their preference for products, including color, flavor, taste, and texture with the following numerical scale:

- 1 = very dislike
- 2 = dislike
- 3 = like
- 4 = really like

2.4. Data Analysis

In this research, the data obtained were analyzed statistically using IBM Statistics SPSS 24 program. The data obtained from the total LAB and TTA tests were analyzed using parametric statistical analysis of *One Way ANOVA* and continued with the *Post Hoc LSD* (Least Significant Difference). While the pH and organoleptic testing data were analyzed using nonparametric statistical analysis of *Kruskall Wallis* and continued with the *Post Hoc Mann Whitney*.

3. Results and discussion

3.1. Microbiological Quality (Total LAB)

The total LAB is one of the important characteristics in the evaluation of fermentation products. In this research, the growth of LAB can be observed after the fermentation process (before foaming) and after freezing and storage for 7 days to evaluate the viability of LAB at freezing and storage in a certain time. The enumeration results of the total LAB at different fermentation times before foaming of this ice cream product are presented in Table 1.

Table 1 Total LAB Test Results of Purple Sweet Potato Probiotic Ice Cream

No.	Fermentation Time (Hours)	Total LAB (CFU/mL)
1.	0	7.16×10^{7a}
2.	6	6.73×10^{8b}
3.	18	4.06×10^{9c}
4.	24	1.82×10^{9d}

Note: Different letters in the same column indicate a significant difference ($p < 0.05$) between the average values

The results of statistical analysis show that the total LAB data are distributed normally and homogeneously, so that the requirements for conducting the test *One Way ANOVA* has been fulfilled. The test results of *One Way ANOVA* show that the fermentation duration significantly affects the total LAB shown with a p value<0.05. Next, *Post Hoc LSD* test was occurred to observe the difference in each treatment fermentation time. Test results of *Post Hoc LSD* indicate that in each treatment fermentation time, there was a real difference to the total LAB. The total LAB increased with the length of fermentation time from 0 hours by 7.16×10^7 CFU/mL reached at 18 hours fermentation time of 4.06×10^9 CFU/mL. Then, LAB began to have a decrease in the number of cells from 18 hours to 24 hours.

The nutrient availability in the medium during the fermentation process affects the growth of LAB. In this research, *L. plantarum* B1765 gets many good sources of nutrients, such as carbohydrates from purple sweet potato extract, protein from skim milk, fat from full cream milk, and whipped cream, as well as sucrose and lactose. *L. plantarum* B1765 is known to have the ability of amylolytic and proteolytic activities (8). This amylolytic activity will hydrolyze starch into simple sugars and used as the main source of energy to grow (9). Besides, nitrogenous compounds resulting from protein hydrolysis by proteolytic activity are used by bacteria for growth nutrition, repair of damaged cells, and DNA/RNA synthesis (10). According to (11), the longer fermentation duration, the greater chance of bacteria utilizing nutrients in the medium to perform metabolism so that cell growth is increasing. However, if these sources of nutrients have been used up and the LAB no longer has energy reserves, its growth will stop and the LAB population will decline.

The research result (12), fermented purple sweet potato ice cream *var. Ayamurasaki* inoculated with 4% *Lactobacillus casei* at 9 hours fermentation time produced a total LAB of 6.73×10^8 CFU/mL. Compared with the results of this research, fermentation for 6 hours with *L. plantarum* B1765 using the same concentration of starter and purple sweet potato varieties produced the same total LAB of 6.73×10^8 CFU/mL. It shows that *L. plantarum* B1765 is able to produce a higher total LAB than fermentation using *L. casei.* The results of different total LAB can be due to differences in the ability of bacterial isolates used in remodeling sugar so that the growth results are also different. Same with research results (13) reported that the ability of *L. plantarum* in using simple confectionery is better than *L. casei* on the fermentation of purple yam flour. In the logarithmic phase, *L. plantarum* has the ability of 43% in utilizing simple sugars as nutrients while *L. casei* is only 16%.

From the data in Table 1, the fermentation time of 18 hours is the best time because it produces the highest total LAB of 4.06×10^9 CFU/mL. This product then was chosen for frothing and storage for 7 days then tested again for the total LAB to determine the viability of *L. plantarum* B1765 in frozen storage. Purple sweet potato probiotic ice cream with fermentation 18 hours after 7 days of storage yields a total LAB of 1.37×10^9 CFU/mL. These results showed that there has been a decrease in the number of LAB after frozen storage but still in a fairly high amount, it has fulfilled the standard as a probiotic product in accordance with (14) that the minimum amount of LAB contained is 10^7 CFU/mL. (15) stated that the factors affecting a decrease in the viabilities of LAB in fermented ice cream products include the existence of antagonistic interactions between starter cultures in nutritional competition, acidic environmental conditions resulting in the inactivation of some bacterial enzymes, the formation of ice crystals when freezing causes the bacterial cell wall to break, and extreme temperatures make bacteria experience stress due to the difference in storage temperature with the optimum temperature of its growth. Despite there is a decrease in the number of LAB, the results show that *L. plantarum* B1765 is able to maintain its viability in frozen storage. This is in accordance with the statement (16) that *L. plantarum* B1765 is able to maintain its viability in frozen storage in gelato synbiotic from soyghurt and lesser yam. Viability of LAB can be maintained due to the addition of skim milk to the product, this is confirmed by the statement of (12) that skim milk can serve as *cryoprotectant* (protective bacteria) during freezing.

3.2. Chemical Qualities (pH and TTA)

The results of statistical analysis showed that the pH values were not normally distributed so the requirements to perform the test *One Way ANOVA* are not fulfilled. In order to analyze the pH value data is done by *Kruskall Wallis* test.

While the TTA data is analyzed statistically normal and homogeneous distribution so that the *One Way ANOVA* test is occurred. The results of pH and TTA testing at different fermentation times can be seen in Table 2.

Table 2 pH and TTA at Various Fermentation Time of Purple Sweet Potato Probiotic Ice Cream

No.	Fermentation Time (Hours)	pH	TTA (%)
1.	0	5.65[a]	0.89[a]
2.	6	5.13[b]	1.12[b]
3.	18	3.64[c]	1.57[c]
4.	24	3.54[d]	2.01[d]

Note: Different letters in the same column indicate a significant difference ($p < 0.05$) between the average values

Test results of *Kruskall Wallis* showed that the duration of fermentation significantly affected the pH value shown with p value<0.05. Test results of *Post Hoc Mann Whitney* showed each treatment of fermentation time showed the real difference in the pH value. Table 2 shows that the pH value of purple sweet potato probiotic ice cream ranges from 3.54-5.65.

In research (17), there was a decrease in pH from 6.3 to 3.4 in purple sweet potato probiotic drinks fermented with *L. plantarum* B1765 up to 48 hours. On the research of (18), there was a decrease in pH from 5.75 to 4.63 in purple sweet potato tapai fermented with yeast for up to 60 hours, and in the result research(19), there was a decrease in pH from 5.04 to 3.68 in purple sweet potato yogurt fermented with mixed cultures *Lactobacillus bulgaricus* and *Streptococcus thermophillus* up to 72 hours. When compared with these researches, the results of this research can decrease the pH faster up to 3.54 with a shorter fermentation duration of 24 hours. These differences can caused by the concentration of the starter, the type of LAB used and the content of nutrients in the media. The more starter concentration is added, it will speed up the process of glucose metabolism into lactic acid (20) and the more sugar sources that can be metabolized, the more organic acids are produced so that the pH value automatically decreases (21).

Test results of *One Way ANOVA* showed that fermentation time significantly affect the TTA with p value<0.05. Test results of *Post Hoc LSD* showed that each treatment of fermentation time were real difference to TTA. Table 2 shows that the TTA value of purple sweet potato probiotic ice cream ranges from 0.89-2.01%. The highest TAT was reached at 24 hours of fermentation According to (22), the total acid value (calculated as % lactic acid) of 0.5% - 2.0% (23). Based on Table 2, it can be seen that purple sweet potato probiotic ice cream products in all treatments have fulfilled the standard with a value of 0.89% - 2.01%.

The results of this research are supported by previous researches which stated that duration fermentation can increase the value of TTA. On purple sweet potato probiotic drink fermented with *L. plantarum* B1765 for up to 48 hours, there is an increase in TTA from 0.090% to 0.630%, (24) and on the tapai of purple sweet potatoes fermented with yeast for up to 60 hours, there is an increase in TTA from 0.55% to 1.12% (25). The different TTA value among these researches were depend on the nutrition available in each product. According to (26), the more sources of sugar available in the media, the more organic acids produced from the metabolic process by LAB. Reviewed from its composition, purple sweet potato probiotic ice cream contains many ingredients that can be used as a source of sugar, such as purple sweet potato, full cream milk, skim milk, and sucrose so that the sugar source is more than with probiotic drinks whose sugar source comes from purple sweet potatoes and sucrose or tapai whose sugar source comes from purple sweet potatoes itself.

It can be seen in Table 2 that the longer fermentation, it can decrease the pH value and increase the total titrated acid. Decrease in pH value and increase in total titrated acid caused by metabolic activity by *L. plantarum* B1765 as a starter culture during the fermentation process. *L. plantarum* B1765 utilizes the nutrients available in the fermentation medium for growth by hydrolyzing the compounds beside monosaccharides, such as hydrolyzing starch into glucose with its amyloytic ability. In addition, sucrose and lactose are known to be degraded. These sugars are further metabolized to produce lactic acid. *L. plantarum* B1765 belongs to the heterofermentative facultative group so that beside the lactic acid, *L. plantarum* B1765 also produces short chain fatty acids (SCFA), such as acetic acid, propionic acid, and butyric acid (27). The duration of fermentation affects the LAB growth, pH value, and TTA. The correlation of fermentation duration to the total LAB, pH, and TTA values is shown in Figure 1.

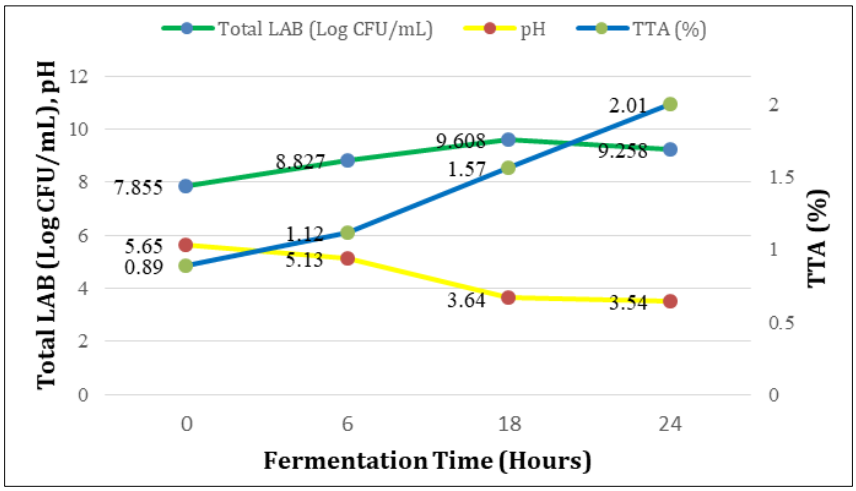

Figure 1 Graph of Correlation of Fermentation Time on the Total LAB, pH value, and TTA

Figure 1 shows that the longer fermentation duration, the total LAB increases to 2 *log cycle* from 7.16 x 10^7 CFU/mL up to 4.16 x 10^9 CFU/mL in fermentation treatment 0-18 hours. This is because the greater chance of bacteria to utilize nutrients in the medium to perform metabolic activities so that cell growth is getting increase. As a result, the TTA values also increase from 0.89% to 2.01% on fermentation duration up to 24 hours because more organic acids are produced as a result of metabolism. Conversely, the longer fermentation leads to a decrease in the pH value of the medium from 5.65 to 3.54 in the fermentation duration up to 24 hours. This is related to the production of organic acids from metabolic products that accumulate into the medium. However, at the time of fermentation 18-24 hours decreased the LAB population to 1.82 x 10^9 CFU/mL because LAB is in the death phase due to unfavorable environmental conditions, such as depleted nutrient availability and too low pH of the medium.

3.3. Organoleptic Quality

To determine the consumer's receptivity to the product, it is necessary to conduct an organoleptic test. The results of organoleptic tests conducted in the research of purple sweet potato probiotic ice cream with different fermentation duration involved color, flavor, taste, and texture which are presented in Table 3.

Table 3 Organoleptic Test Results of Purple Sweet Potato Probiotic Ice Cream

Parameter	Hedonic Test Mean Value			
	0 Hours	6 Hours	18 Hours	24 Hours
Color	3.53 ± 0.571[a]	3.43 ± 0.626[a]	3.10 ± 0.622[a]	3.40 ± 0.724[a]
Flavor	3.47 ± 0.571[a]	3.37 ± 0.615[a]	2.53 ± 0.819[b]	2.60 ± 0.968[b]
Taste	3.73 ± 0.450[a]	3.43 ± 0.679[a]	2.57 ±0.860[b]	2.67 ± 0.844[b]
Texture	3.63 ± 0.490[a]	3.40 ± 0.621[b]	3.17 ± 0.747[b]	3.10 ± 0.803[b]

Note: Different letters on the same line indicate a significant difference ($p < 0,05$) between the average values

Based on non-parametric statistical test results of *Kruskal-Wallis,* it can be seen that the duration of fermentation does not significantly affect the color parameters, but significantly affects the parameters of flavor, taste, and texture.

Based on Table 3, the average values of organoleptic tests on samples for color parameters ranged from 3.10-3.53 (like-very like). The duration of fermentation did not have a significant effect on panelists preferences for the color of purple sweet potato probiotic ice cream. Purple sweet potatoes contain anthocyanin pigments that can change color due to the pH (23) influence. Anthocyanin is a red pigment whose molecular structure is stable at low pH and when the pH is raised, the stability will decrease (24). The most stable form is at pH 1-2 (25). At pH 1 anthocyanins form flavilium cations are red color. At pH 2-4 anthocyanins shape a mixture of flavilium cations and carbinol (colorless) so that the color is faded red. At pH 5-6 there are two compounds, namely quinoidal (blue/purple) and chalcone (colorless). This is because anthocyanins are very reactive and easily have electron deficiency reactions resulting in color discoloration. In the results of this research, purple sweet potato probiotic ice cream with a fermentation time of 0 hours (control) has

a dark purple color, a fermentation time of 6 hours has a reddish-purple color, with a fermentation time of 18 hours has a pink color, and with a fermentation time of 24 hours has a dark pink color. Although visually the ice cream color is different because of the difference in pH value, the level of panelists preference does not show a significant influence. It can be interpreted that all the colors are classified as preferred panelists with a relatively similar level of preference. The difference color in each duration fermentation treatment of purple sweet potato probiotic ice cream can be seen in Figure 2.

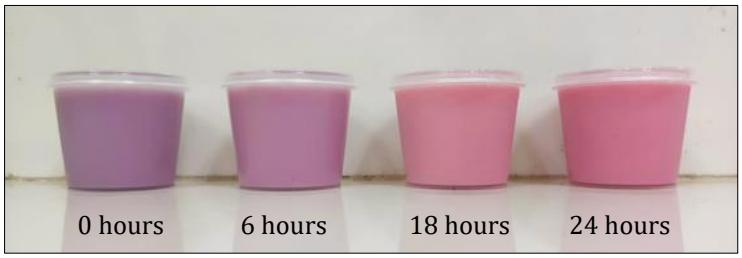

Figure 2 Purple Sweet Potato Probiotic Ice Cream (*Ipomea batatas*)

Based on Table 3, the results show that fermentation time has a significant influence on panelist's preference for the flavor of purple sweet potato probiotic ice cream. Fermentation treatment causes the formation of acid flavor due to the resulting flavor-forming compounds from the activity of sugar metabolism by bacteria, such as lactic acid, acetaldehyde, acetic acid, and acetyl (26). Based on the research, it can be seen that the longer duration fermentation, the lower score of flavor preference. This is because along with the duration of fermentation, the lactic acid bacteria have a longer time to grow and perform metabolic activities that produce lactic acid so that the flavor of lactic acid formed stronger and less favored by panelists. A shorter fermentation time of 6 hours produces in a purple sweet potato probiotic ice cream with a lactic acid flavor that is not too strong so it is acceptable and preferred by panelists. Panelists preference score for the flavor of purple sweet potato probiotic ice cream in all treatments ranged from 2.57 to 3.73 (like-very like). Thus, it can be said that the flavor of purple sweet potato probiotic ice cream on all fermentation long treatments is acceptable and preferred by panelists.

Based on Table 3, the results show that fermentation duration has a significant influence on panelist's preference for the taste of purple sweet potato probiotic ice cream. During the fermentation process, LAB produces organic acids, such as lactic acid, acetic acid, propionic acid, and butyric acid that can affect the flavor on the products (11). Based on this research, it can be seen that the longer the fermentation duration, the lower score preference of the taste. This is because the longer fermentation, the more organic acids produced. As a result, the taste of the purple sweet potato probiotic ice cream becomes sourer. A shorter fermentation time of 6 hours produces purple sweet potato probiotic ice cream with a more dominant sweet taste, so that panelists prefer it. This is because with a short fermentation time, LAB have not grown much so that the source of sugar in the medium is still not widely used to be metabolized to produce lactic acid and other organic acids. Panelists preference score for the taste of purple sweet potato probiotic ice cream in all treatments ranged from 2.57 to 3.73 (like-really like). Thus, it can be said that the taste of purple sweet potato probiotic ice cream on all fermentation long treatment is acceptable and favored by panelists.

Based on Table 3, the duration of fermentation has a significant influence on panelist's preference for the texture of purple sweet potato probiotic ice cream. Panelists preference score for the texture of purple sweet potato probiotic ice cream in all treatments ranged from 3.10 to 3.63 (like-really like). Based on the research, it can be seen that the longer fermentation, the lower score of texture preference. The texture of the ice cream is affected by the increase in ice cream volume (overrun). Ice cream with the high overrun produces soft texture (27). However, the activity of LAB during the fermentation process can increase the similarity and decrease the pH value. The increased similarity will precipitate the casein so that its viscosity also increases. High viscosity will prevent air capture at the time of frothing so that the ice cream has difficulty to expand (12). In line with the results of this research, fermentation for 0 hours produced a softer ice cream texture than other treatments. This is because the protein has not experienced denaturation. Hence, the dough's viscosity is low and at the time of frothing the dough is easier to expand because the air easily penetrates into the dough.

4. Conclusion

Based on the results that have been done, it shows that the duration of fermentation of purple sweet potato probiotic ice cream significantly affects the chemical qualities (pH and TTA), microbiological quality (total LAB), as well as the

preference for flavor, taste, and texture but do not significantly affect the color. Purple sweet potato probiotic ice cream with a fermentation time of 18 hours is the best treatment with a total LAB of 1,37 x 10^9 CFU/mL, pH value of 3.64, TTA of 1.57%, and the level of preference to the color of 3.10; flavor 2.53; taste 2.57; and texture 3.17.

The suggestion is that it is necessary to add other ingredients to increase the acceptance of purple sweet potato probiotic ice cream, especially to improve the flavor and taste parameters.

Compliance with ethical standards

Acknowledgments

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Disclosure of conflict of interest

The authors declare that there is no conflict of interest.

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